

SECONDARY STRESSES IN 112 FOOT
RAILROAD PONY TRUSS

BY

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ARMOUR INSTITUTE OF TECHNOLOGY

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Secondary stresses in 112
foot railroad pony truss



SECONDARY STRESSES IN 112 FOOT
RAILROAD PONY TRUSS ²¹²⁰³/₃₅

A THESIS

PRESENTED BY

A. APPELBAUM AND S. ISAACSON

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IN

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Professor of Civil Engineering

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Preface.

The analysis of Secondary Stresses, although such stresses were recognised by engineers in their designs, has been considered a very laborious operation and until recently their computation was deemed unnecessary in most cases.

The purpose of this thesis is to present a systematic method for the solution and a convenient arrangement of the calculations, and also to show the importance of secondary stresses in trusses of relatively small proportions.

The authors have not attempted to introduce or apply any new theory. For the derivation of the formulae, the reader is referred to an excellent treatise on the subject by Johnson, Bryan, and Turneaure "Modern Framed Structures" - Part 2.

The authors have chosen what they believe to be a typical problem, and it is hoped that the present work will prove of benefit to those desirous of acquiring a working knowledge of the subject.

May 25, 1921.

Chicago, Ill.

1. The first part of the paper is devoted to a general discussion of the problem of the origin of life. It is shown that the problem is one of the most important and most difficult in the history of science. The author discusses the various theories of the origin of life, and shows that the most plausible is the theory of spontaneous generation.

2. The second part of the paper is devoted to a detailed discussion of the theory of spontaneous generation. The author shows that this theory is based on the fact that life is a complex of many different parts, and that these parts are all derived from a common ancestor.

3. The third part of the paper is devoted to a discussion of the evidence in favor of the theory of spontaneous generation. The author shows that there is a great deal of evidence in favor of this theory, and that it is the most plausible of all the theories of the origin of life.

4. The fourth part of the paper is devoted to a discussion of the objections to the theory of spontaneous generation. The author shows that these objections are all based on a misunderstanding of the theory, and that they are all easily refuted.

5. The fifth part of the paper is devoted to a discussion of the conclusions of the author. The author concludes that the theory of spontaneous generation is the most plausible of all the theories of the origin of life, and that it is the only one that is based on the facts of the case.

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Primary and Secondary Stresses Defined.

In the analysis of stresses in a truss it is usually assumed :

(1) The joints lie in the gravity axes of the members.

(2) All external loads and weights of members are applied at the joints only.

(3) All members are free to turn at the joints.

(4) All members are straight, and remain straight after the loads are applied.

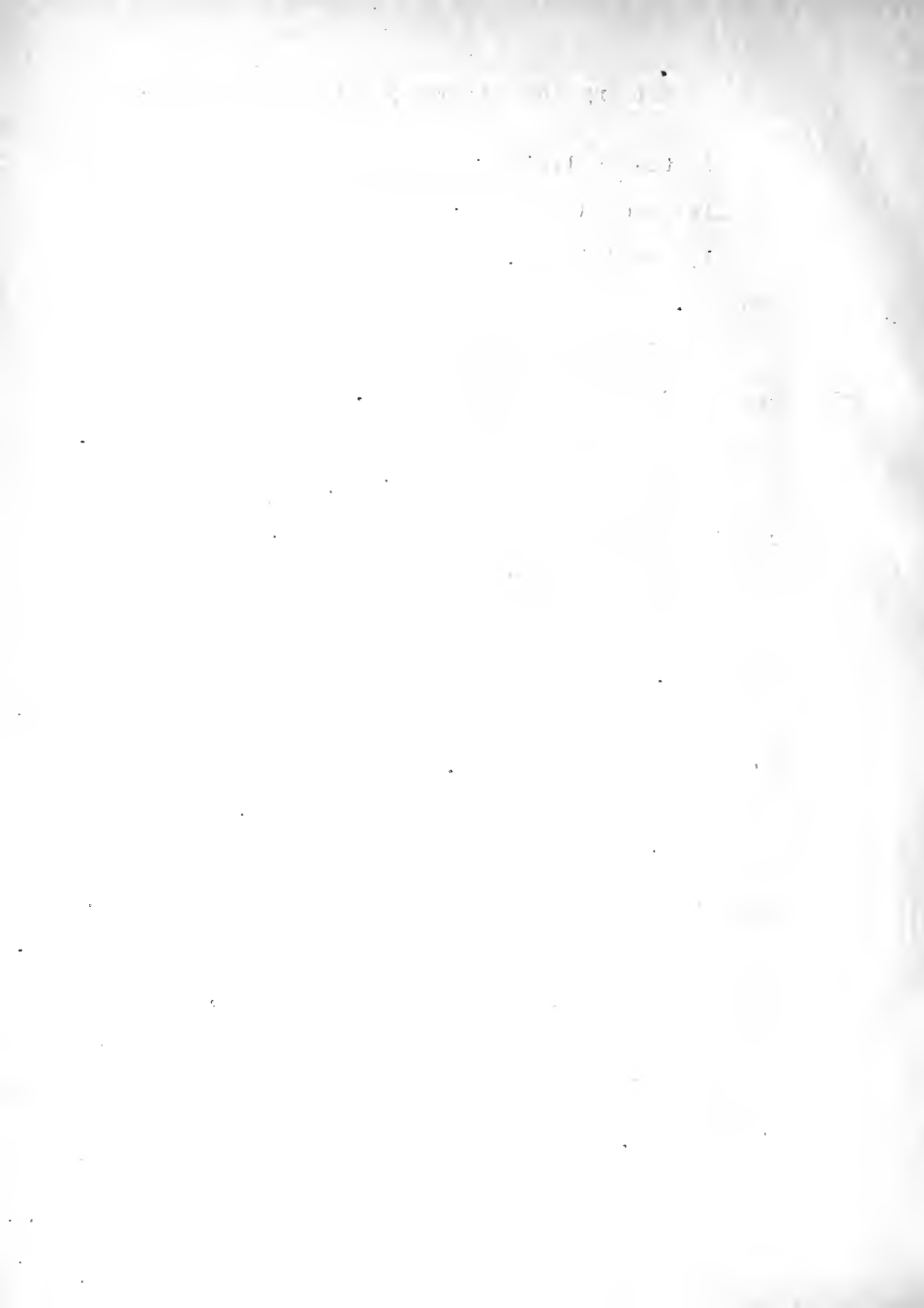
The stresses resulting from a determination based on these assumptions are called " Primary " or direct stresses.

That these assumptions are not realized in practice is easily apparent.

(1) The joints are often eccentric.

(2) The weights of the individual members are carried to the joints by the members acting as beams.

(3) The members are not free to turn at the joints. This must be true in riveted connections, and is true to a considerable extent even in pin connections, because there is always friction between the pin and the member.



(4) The members themselves are not straight and do not remain straight after the loads are applied. Since the members are rigid at the joints, a change in relative position of the joints due to the primary stresses will introduce a single or double bending in the member.

The stresses resulting from this bending due to the rigidity of the joint connections and the other factors mentioned are called " Secondary Stresses."

It has been found that the most important of the secondary stresses are the bending stresses, and consequently an analysis of the other secondary stresses has been omitted.

Formulae.

Calculation of the changes of angle in any triangle in terms of the changes in the lengths of the members.

$$da = \frac{s_3 - s_2}{E} \cot B + \frac{s_3 - s_1}{E} \cot Y \quad (1)$$

$$dB = \frac{s_1 - s_3}{E} \cot Y + \frac{s_1 - s_2}{E} \cot a \quad (2)$$

$$dY = \frac{s_2 - s_1}{E} \cot a + \frac{s_2 - s_3}{E} \cot B \quad (3)$$

The deflection angles of a beam subjected to given moments applied at the two ends.

$$M_1 = \frac{2EI}{l} (2T_1 + T_2) \quad (4)$$

$$M_2 = \frac{2EI}{l} (2T_2 + T_1) \quad (5)$$

Values of the deflection angles T in terms of the changes of angle da, etc.

$$T_{nm} = T_{n1} + \sum_1^n da \quad (6)$$

The moments at any joint in terms of the deflection angles T.

(See formula 17, page 432- Johnson, Bryan, Turneaure,- Part 11.)

(7)

The moment and fibre stress in terms of T.

$$M_{nm} = 2 EK_{nm} (2T_{nm} + T_{nn}) \quad (8)$$

$$f_{nm} = \frac{2Ec}{1} (2T_{nm} + T_{nn}) \quad (9)$$

In these equations M_{nm} and f_{nm} are respectively the bending moments and fibre stress at joint n in member nm, and c = distance of fibre from neutral axis.

Explanation of Tables.

Table A. Data necessary for the determination of constants.

Table B. Calculation of changes of angle, arranged by triangles.

Table C. Calculation of ΣdL and $K\Sigma dL$ at the several joints.

Table D. Formulation of equations using Table C.

Table E. Solution of equations.

Table F. Determination of fibre stress for each member at each joint.

Table G. Values of secondary stresses in terms of percentage of maximum primary stresses.



Bibliography.

Johnson, Bryan, and Turneaure. Part 2.

Grimm " Secondary Stresses in Bridge Trusses ".

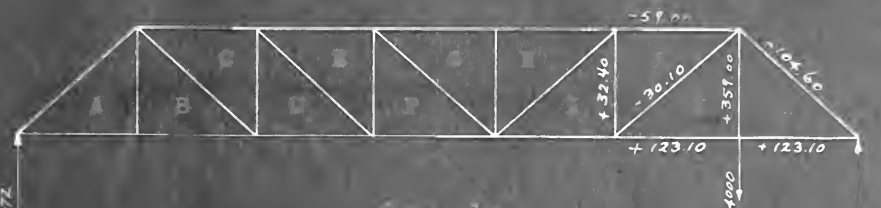
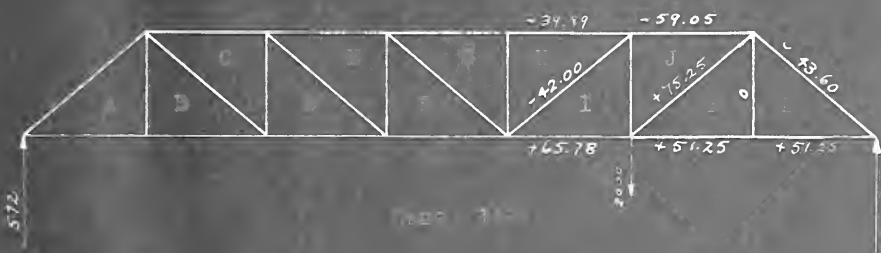
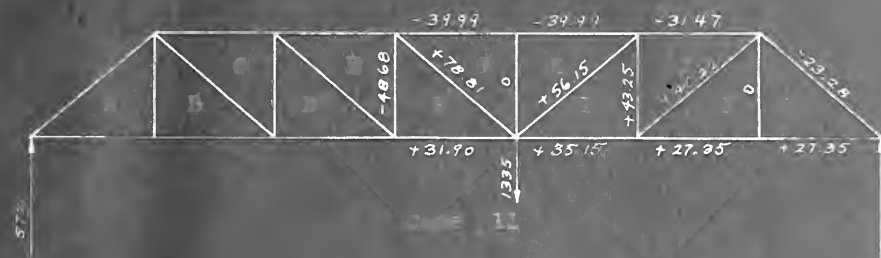
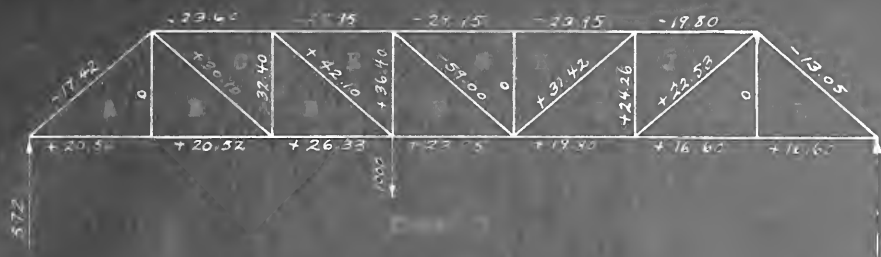
A.R.E.A. 1914, Volume 15 of Proceedings.

Waddell- Engineering News, 1914.

Engineering News, 1912.

Turneaure- Engineering News, 1912.

F.C.Kung- Engineering News, Volume 66, page 397.







Tri-Angle	Angle	(1.3333) Factor of cot a	(.7500) Factor of cot	dL
A	1	---	0	14.25
	2	-17.42	-17.42	-63.71
	3	23.60	---	50.88
B	3	30.10	30.10	35.39
	4	---	---	-12.79
	5	---	0	-22.60
C	3	---	-32.40	-46.83
	4	-23.60	-30.10	-71.60
	5	30.10	30.10	118.43
D	4	42.10	4.10	76.90
	5	26.53	---	-21.05
	6	---	-32.40	-55.85
E	5	---	36.40	-5.70
	6	-23.60	---	-96.00
	7	42.10	42.10	101.70
F	6	-59.00	-59.00	-178.30
	7	23.95	---	82.95
	8	---	36.40	96.40
G	7	---	0	59.00
	8	-59.00	-59.00	-88.05
	9	-29.95	---	22.05
H	8	31.42	31.42	85.79
	9	-23.95	---	-54.37
	10	---	0	-31.42
I	9	---	24.26	-5.37
	10	19.80	---	-15.50
	11	31.42	31.42	20.87
J	10	22.53	22.53	55.20
	11	-19.80	-24.26	-56.50
	12	---	24.26	1.30
K	11	---	0	-16.90
	12	16.60	-22.53	-7.91
	13	22.53	22.53	24.81
L	12	16.60	---	39.56
	13	-13.05	-10.05	-49.36
	14	---	0	9.00

TABLE B-2

Tri-angle	Angle	Factor of cot α (1.3333)	Factor of cot β (1.3333)	dx
E	5	---	-43.05 - 40.10	- 18
	6	-19.95 -42.10	---	- 10
	7	40.10 39.95	-42.10 -40.10	16.18
F	6	78.81 -31.90	78.81 48.68	164.25
	7	31.90 -78.81	---	-62.50
	9	---	-48.68 -78.81	-95.75
G	7	---	0 -78.81	-58.15
	8	78.81 31.99	78.81 - 0	217.55
	9	-39.99 -78.81	---	-158.40
H	9	56.15 39.99	56.15 - 0	170.30
	9	-39.99 -56.15	---	-120.20
	10	---	0 -56.15	- 42.10
I	9	---	43.25 -56.15	- 9.67
	10	35.15 -56.15	---	- 28.00
	11	56.15 -35.15	56.15 -43.25	37.67
J	10	40.22 31.47	40.22 -43.25	93.33
	11	-31.47 -40.22	---	-95.60
	12	---	43.25 -40.22	2.27
K	11	---	0 -40.22	-30.16
	12	37.35 -40.22	---	-17.16
	13	40.22 -37.35	40.22 - 0	47.51
L	12	---	---	---
	13	7.35 33.23	---	67.43
	14	-33.23 -7.35	-33.23 - 0	-60.09
	15	---	0 -33.23	17.46



Joint	Period	1	2	3	ΣdL	ΣΣ
1	1-2	1.0	1.0	1.0	3.0	3.0
2	3-4	1.0	1.0	1.0	3.0	3.0
3	5-6	1.0	1.0	1.0	3.0	3.0
4	7-8	1.0	1.0	1.0	3.0	3.0
5	9-10	1.0	1.0	1.0	3.0	3.0
6	11-12	1.0	1.0	1.0	3.0	3.0
7	13-14	1.0	1.0	1.0	3.0	3.0
8	15-16	1.0	1.0	1.0	3.0	3.0
9	17-18	1.0	1.0	1.0	3.0	3.0
10	19-20	1.0	1.0	1.0	3.0	3.0
11	21-22	1.0	1.0	1.0	3.0	3.0
12	23-24	1.0	1.0	1.0	3.0	3.0
13	25-26	1.0	1.0	1.0	3.0	3.0
14	27-28	1.0	1.0	1.0	3.0	3.0
15	29-30	1.0	1.0	1.0	3.0	3.0
16	31-32	1.0	1.0	1.0	3.0	3.0
17	33-34	1.0	1.0	1.0	3.0	3.0
18	35-36	1.0	1.0	1.0	3.0	3.0
19	37-38	1.0	1.0	1.0	3.0	3.0
20	39-40	1.0	1.0	1.0	3.0	3.0
21	41-42	1.0	1.0	1.0	3.0	3.0
22	43-44	1.0	1.0	1.0	3.0	3.0
23	45-46	1.0	1.0	1.0	3.0	3.0
24	47-48	1.0	1.0	1.0	3.0	3.0
25	49-50	1.0	1.0	1.0	3.0	3.0
26	51-52	1.0	1.0	1.0	3.0	3.0
27	53-54	1.0	1.0	1.0	3.0	3.0
28	55-56	1.0	1.0	1.0	3.0	3.0
29	57-58	1.0	1.0	1.0	3.0	3.0
30	59-60	1.0	1.0	1.0	3.0	3.0
31	61-62	1.0	1.0	1.0	3.0	3.0
32	63-64	1.0	1.0	1.0	3.0	3.0
33	65-66	1.0	1.0	1.0	3.0	3.0
34	67-68	1.0	1.0	1.0	3.0	3.0
35	69-70	1.0	1.0	1.0	3.0	3.0
36	71-72	1.0	1.0	1.0	3.0	3.0
37	73-74	1.0	1.0	1.0	3.0	3.0
38	75-76	1.0	1.0	1.0	3.0	3.0
39	77-78	1.0	1.0	1.0	3.0	3.0
40	79-80	1.0	1.0	1.0	3.0	3.0
41	81-82	1.0	1.0	1.0	3.0	3.0
42	83-84	1.0	1.0	1.0	3.0	3.0
43	85-86	1.0	1.0	1.0	3.0	3.0
44	87-88	1.0	1.0	1.0	3.0	3.0
45	89-90	1.0	1.0	1.0	3.0	3.0
46	91-92	1.0	1.0	1.0	3.0	3.0
47	93-94	1.0	1.0	1.0	3.0	3.0
48	95-96	1.0	1.0	1.0	3.0	3.0
49	97-98	1.0	1.0	1.0	3.0	3.0
50	99-100	1.0	1.0	1.0	3.0	3.0



Calculation of IdL and K IdL

Case 1

Joint	Member	P	Q	dL	IdL	K IdL
1	1-2	1000	1000	13.00	13.00	300.55
	1-3	49.42	49.42			102.55
2	2-1	1000	1000			1000.00
	2-3	15.8	15.8			400.10
3	3-1	49.42	49.42			1000.00
	3-2	1000	1000			1000.00
4	4-1	1000	1000			1000.00
	4-2	1000	1000			1000.00
5	5-1	1000	1000			1000.00
	5-2	1000	1000			1000.00
6	6-1	1000	1000			1000.00
	6-2	1000	1000			1000.00
7	7-1	1000	1000			1000.00
	7-2	1000	1000			1000.00
8	8-1	1000	1000			1000.00
	8-2	1000	1000			1000.00
9	9-1	1000	1000			1000.00
	9-2	1000	1000			1000.00
10	10-1	1000	1000			1000.00
	10-2	1000	1000			1000.00
11	11-1	1000	1000			1000.00
	11-2	1000	1000			1000.00
12	12-1	1000	1000			1000.00
	12-2	1000	1000			1000.00
13	13-1	1000	1000			1000.00
	13-2	1000	1000			1000.00
14	14-1	1000	1000			1000.00
	14-2	1000	1000			1000.00



Table 1

Calculation of 20-400 Hz

Case 1)

Set	Q		1	2	Σ	20
	-7	20.0				
12	1-11	4.77	1-1-11	0.77		138.00
	1-10	2.00	12-1-10		6.00	10.00
		4.77				
13	1-11	1.00				
	1-10	1.00	1-1-10	49.01	47.01	10.00
	1-11	1.00	1-1-11	0.00	80.77	0.00
14	14-1	1.00				181.70
	14-1	1.00				
		1.00	1-1-13		0.00	0.00
		1.00				481.00



TABLE C-2
Calculation of ΣM and ΣF

Case II

Joint	Member	F	Angle	ΣF	ΣM	Kcal.
5	5-2	23.50	---	---	---	---
	5-6	3.75	7-2-0	---	65.18	187.20
	5-4	2.54	0-2-0	110.27	40.23	17.90
	5-7	2.10	4-2-0	---	---	7.90
		50.89				324.90
6	6-4	48.52	---	---	---	---
	6-7	3.75	5-2-0	---	51.5	1.80
	6-9	1.09	7-2-7	120.00	1.11.5	1.90
	6-8	1.47	7-2-5	1.47	1.47	1.55
		54.83				3.25
7	7-2	3.0	---	---	---	---
	7-6	3.75	6-2-0	110.27	---	30.00
	7-8	3.03	6-2-0	---	1.11.5	1.80
	7-9	2.10	4-2-5	100.1	4.4.5	1.10
		11.13				7.20
8	8-10	23.50	---	---	---	---
	8-9	1.09	10-2-0	172.0	170.50	24.5
	8-7	2.10	4-2-0	17.2	32.5	105.0
	8-11	47.42	---	---	---	12.45
9	9-1	1.47	---	---	---	---
	9-2	1.75	0-2-0	---	9.75	1.15
	9-10	2.71	7-2-0	157.40	34.15	79.0
	9-11	11.32	10-2-10	15.0	35.25	11.00
		16.54			59.23	87.75
10	10-13	3.0	---	---	---	---
	10-9	3.75	7-10	20.2	9.75	20.0
	10-8	2.10	11-10-5	23.60	6.23	173.0
	10-6	23.50	3-10-5	4.10	8.23	1.0
		30.35				9.75
11	11-9	1.47	---	---	---	---
	11-10	2.71	9-11-10	17.7	27.7	44.48
	11-12	3.77	10-11-12	30.0	6.23	27.0
	11-13	11.35	1-13-13	30.1	---	136.00
		16.53				160.7
12	12-14	1.45	---	---	---	---
	12-15	1.75	10-12-15	17.3	57.12	157.30
	12-11	4.77	10-11-11	17.15	50.23	259.80
	12-10	23.50	11-10-10	1.7	8.23	1182.0
		31.47				160.00
13	13-11	1.45	---	---	---	---
	13-12	1.75	10-11-12	17.31	57.1	157.0
	13-14	11.35	1-11-14	30.02	6.23	27.0
	13-13	23.50	---	---	---	---
		36.55				161.70
14	14-13	1.85	---	---	---	---
	14-12	18.93	13-14-12	32.66	5.25	45.00
	14-11	23.49	---	---	---	455.00

Case III

Calculation of ΣdL and ΣdE

Case III

Col. t	Number	K	Angle	ΣdL	ΣdE
3	4-10	28.0	---	---	---
	5-6	1.09	10-11	-24.16	-1.00
	5-7	22.0	10-11	10.20	0.00
		49.09			0.00
3	1-4	1.70	---	---	---
	5-6	1.09	10-11	-24.16	-1.00
	6-10	1.70	10-11	-24.16	-1.00
	7-11	1.70	10-11	-24.16	-1.00
	7-12	1.70	10-11	-24.16	-1.00
		4.00			0.00

TABLE C-3

Calculation of $\Sigma \phi L$ and $K \phi L$

Case 111

Joint	Member	K	Angle	ϕL	$\Sigma \phi L$	$K \phi L$
9	9-10	23.70				
	9-9	1.09	10-5-9	-34.10	-34.10	-7.38
	9-7	25.00	9-0-7	-17.55	183.37	-423.20
		47.40				41.0.77
9	9-6	3.70				
	9-7	1.70	6-3-7	-35.75	-35.75	-11.00
	9-9	1.09	7-3-9	-15.40	-259.15	-37.00
	9-10	2.71	5-9-10	-5.65	-281.17	-74.00
10	9-11	1.09	10-9-11	55.1	-15.50	-3936.00
		4.55				20.00.0
	10-12	1.50				
	10-11	1.4	0-1-11	-11.19	1.70	47.00
10	10-9	1.71	10-10-	18.00	18.00	19.00
	10-	1.0	-10-	-11.0	1.7	1.00
		10.00				10.00
						10.00
11	11-0	1.09				
	11-10	1.74	-1-10	-17.00	-10.0.1	-347.0
	11-12	4.77	10-11-12	-17.00	-10.0.1	-347.0
	11-9	11.81	1-1-9	-1.40	-10.0.10	-34.00
12	11-12	10.7				
	12-13	3.4				
	12-11	1.7	12-1-10	-11.00	-10.0.1	-347.0
	12-	1.0.0	-1-10-	-10.00	-10.0.1	-347.0
13	12-13	1.0.0	12-1-11	-1.00	-10.0.1	-347.0
	13-14	1.0.0				
	13-11	1.0.0				
	13-12	1.0.0				
14	13-14	1.0.0				
	14-15	1.0.0				
	14-13	1.0.0				
	14-12	1.0.0				

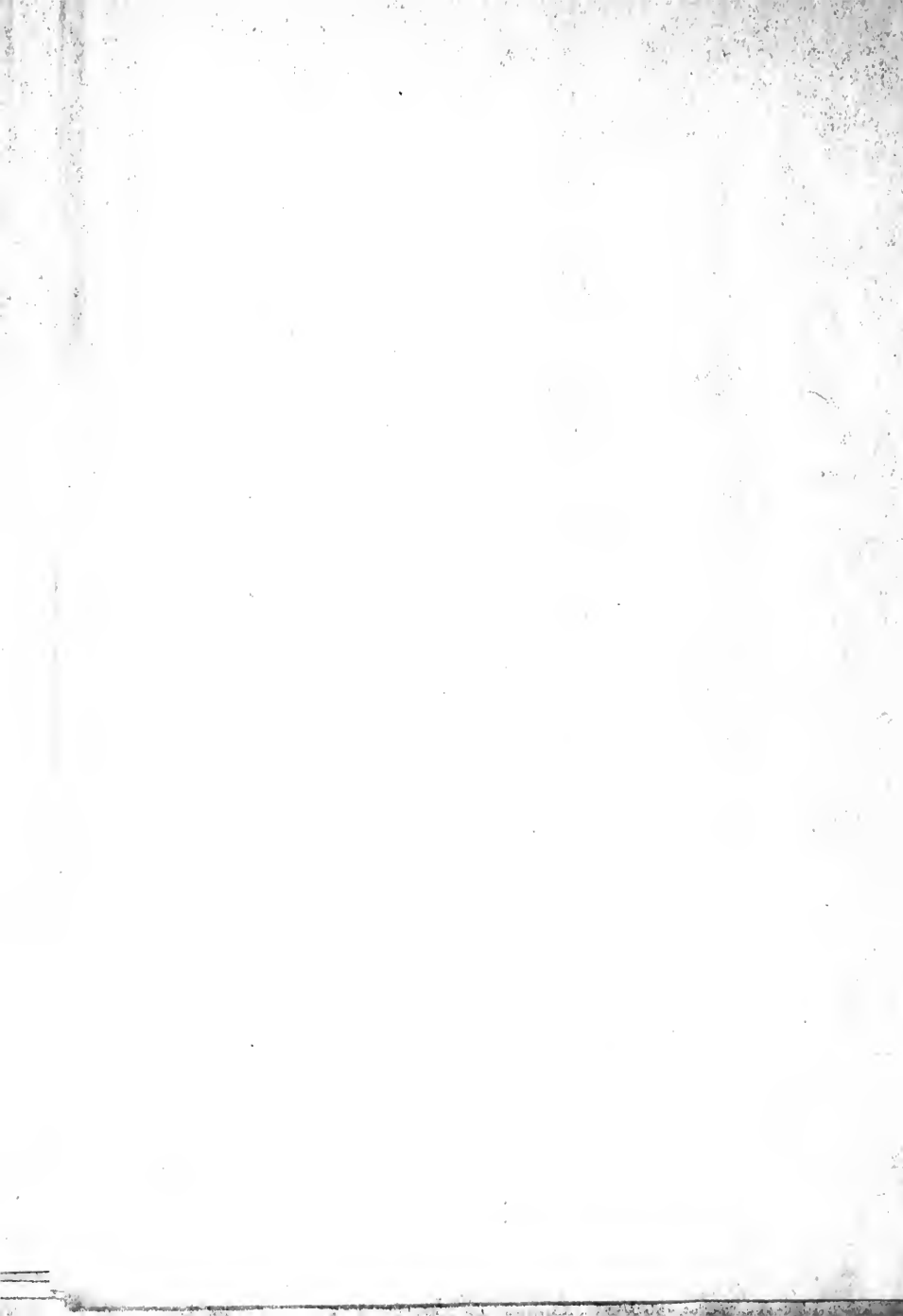
Calculation of ΣH_L and ΣH_U

Page 17

Job #	Cost	Σ	mi	Σ	ΣH_L
10	10-10	10	---	---	---
	10-11	10.4	1-10-11	---	---
	10-8	10.7	1-10-8	10.0	10.0
	10-9	10.0	1-10-9	10.0	10.0
		10.0			10.0
12	12-10	10.4	---	---	---
	12-11	10.4	1-12-11	---	---
	12-8	10.7	1-12-8	10.0	10.0
	12-9	10.0	1-12-9	10.0	10.0
		10.0			10.0
13	13-10	10.4	---	---	---
	13-11	10.4	1-13-11	---	---
	13-8	10.7	1-13-8	10.0	10.0
	13-9	10.0	1-13-9	10.0	10.0
		10.0			10.0
15	15-10	10.4	---	---	---
	15-11	10.4	1-15-11	---	---
	15-8	10.7	1-15-8	10.0	10.0
	15-9	10.0	1-15-9	10.0	10.0
		10.0			10.0
14	14-10	10.4	---	---	---
	14-11	10.4	1-14-11	---	---
	14-8	10.7	1-14-8	10.0	10.0
	14-9	10.0	1-14-9	10.0	10.0
		10.0			10.0

Tabulation of Equations

No. of Joint	Form Number or Equation	Absolute Terms			
		Case 1	Case 11	Case 111	Case
1	$65.887_1 + 15.857_2 + 16.887_3$	260.10			
2	$15.667_1 + 17.777_2 + 2.777_3 + 16.887_4$	- 1197.46			
3	$15.927_1 + 17.777_2 + 17.887_3 + 4.777_4 + 16.887_5$	187.85			
4	$16.887_1 + 1.777_2 + 11.887_3 + 8.887_4 + 16.887_5$	- 2043.35			
5	$22.807_1 + 1.777_2 + 16.887_3 + 6.777_4 + 22.807_5$	- 9252.44	- 1389.90		
6	$16.887_1 + 1.777_2 + 1.777_3 + 1.077_4 + 16.887_5$	13894.09	1020.12		
7	$22.807_1 + 1.077_2 + 16.887_3 + 22.807_4 + 1.777_5$	- 11766.65	7933.99		



Calculation of Equations

No.	Equation	Absolute Terms			
		Case 1	Case 11	Case 111	Case 1V
1	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	100.00			
2	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	110.00			
3	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	120.00			
4	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	130.00			
5	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	140.00			
6	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	150.00			
7	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	160.00			
8	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	170.00			
9	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	180.00			
10	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	190.00			
11	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	200.00			
12	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	210.00			
13	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	220.00			
14	$1.0000 \times 10^{-1} + 1.0000 \times 10^{-2}$	230.00			

m	n	10										
			1	2	3	4	5	6	7	8	9	0
			121.60	4.04	16.85	-	17.03	1.00	1.00	1.00	1.00	1.00
			.01	.06			.40	1.00	-	1.00	-	1.00
			.12	4.37	.10	.97	-	7.90	1.00	-	10.00	-
			1.90	-3.73	-0.25			749.00	1.00	0.00	1.00	1.00
I	5.00	4.74	3.36	1.10	17.0	17.0	-11.7	27.0	-	.5	-1.0	.1 - 0.0 14.3
II	8.02	16.8	1.00	-10.0	1.9	-	.2	8.8	0.1	1.1	1.3	-
III	1.00	18.1	8.03	-2.0	-27.0	-	.8	7.1	1.0	1.0	1.0	-
IV	0.37	16.1	1.77	-10.0	-	-	4.0	1.1	1.1	1.1	1.1	1.1

TABLE F (cont.)

edgewise readings

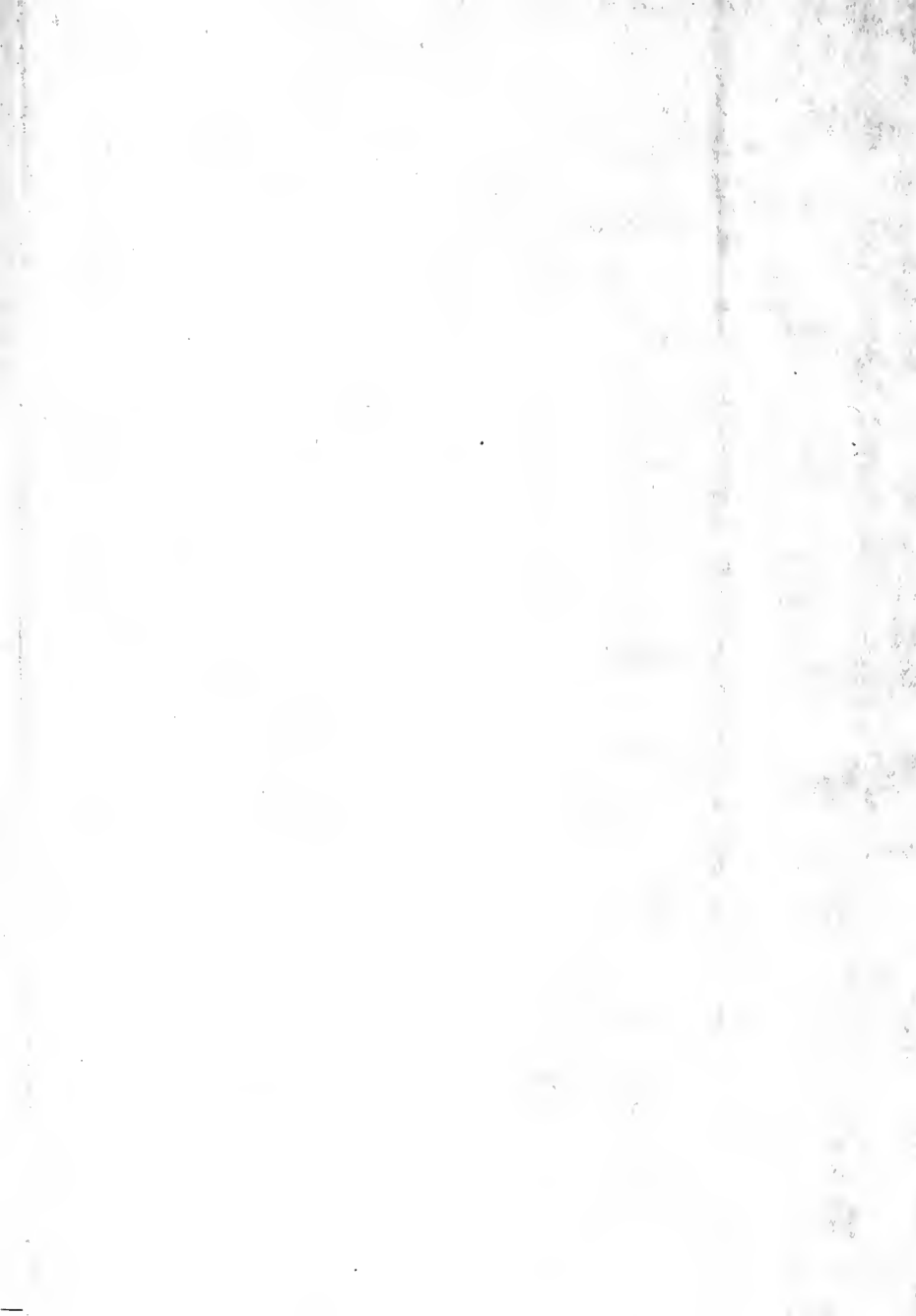


Joint	Member	$\frac{e}{l}$	Case 1 1000 # at point e		
			r	$2r_{ym} + T_{mm}$	f
I	1-3	.029	5.06	3.13	0.40
	1-5	.048	6.03	3.13	-
	1-8	.006	13.12	31.30	0.66
9	2-1	.059	- 4.74	6.63	1.00
	2-3	.047	- 33.35	- 100.13	- 15.10
	2-5	.000	- 33.74	0.00	- 15.10
11	11-9	.066	24.03	104.11	13.03
	11-10	.042	34.55	134.07	16.36
	11-12	.002	- 21.36	- 11.45	- 0.00
	11-13	.003	- 33.64	- 45.87	- 6.23
	11-14	.029	- 30.00	- 57.82	- 2.14
12	12-13	.027	18.05	75.13	9.38
	12-11	.026	11.52	11.76	0.43
	12-19	.008	33.38	3.80	- 0.07
	12-17	.004	10.03	0.31	.03
13	13-15	.009	34.14	97.82	9.16
	13-14	.025	- 10.32	- 17.60	- 3.03
	13-12	.003	1.73	4.62	- 0.04
14	14-13	.003	13.70	0.30	0.20
	14-15	.015	14.03	0.14	- 0.09
	14-12	.015	14.03	0.14	- 0.09

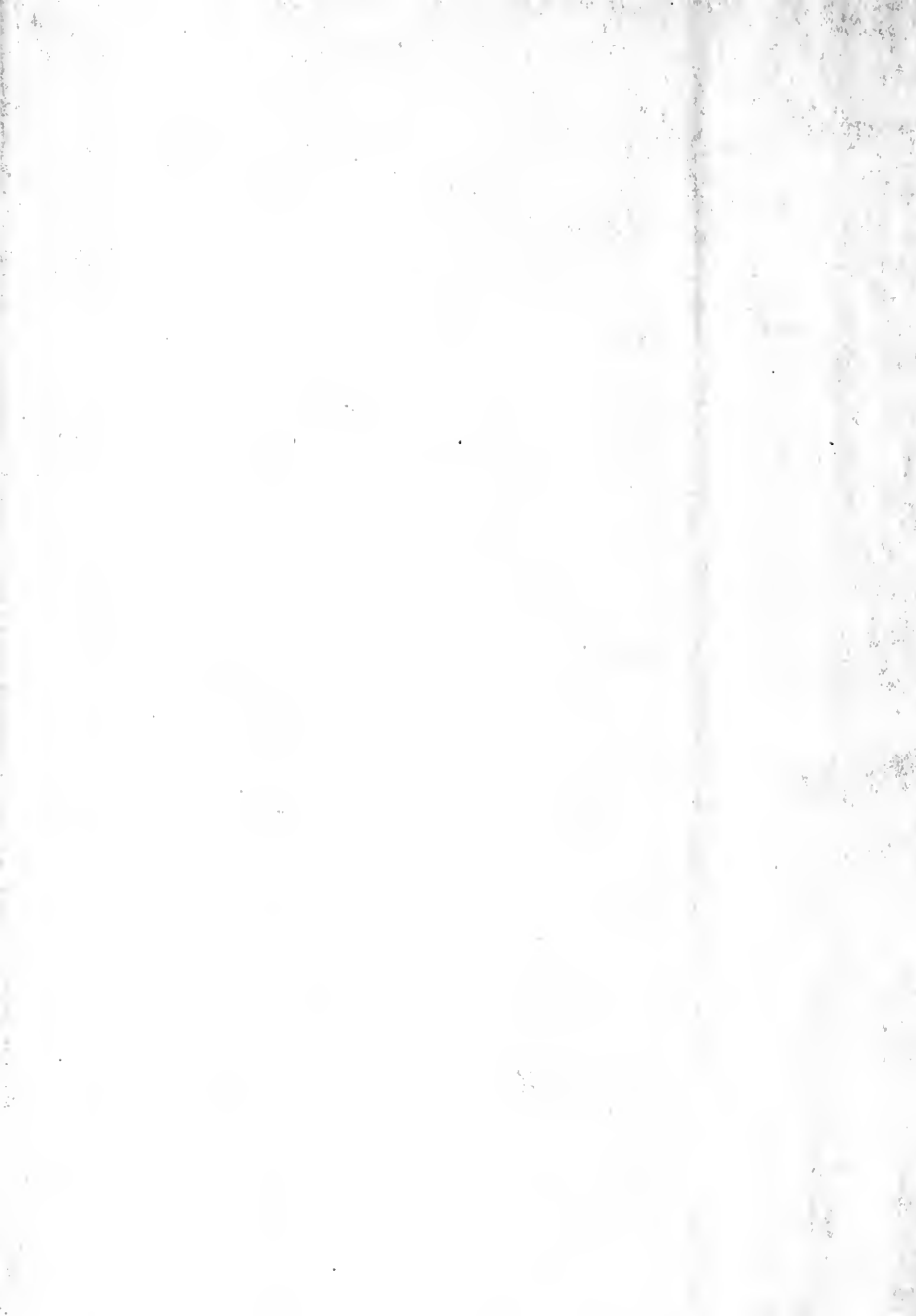
Total	Position	$\frac{C}{I}$	Case 11 1000 # at point 9		
			T	$2T_{min} + T_{max}$	F
1	1-0	.039	9.33	9.33	0.53
	1-1	.048	2.06	2.06	0.73
	1-2	.058	31.22	31.22	2.36
	6-1	.058	- 13.76	- 13.76	-
11	11-0	.058	- 41.14	- 41.14	- 10.44
	11-10	.058	41.77	- 44.11	- 3.84
	11-16	.048	119.44	267.86	14.78
	11-18	.030	23.84	71.25	3.04
	11-18	.058	- 3.63	- 9.70	- 0.77
19	19-0	.058	- 36.03	- 36.03	- 1.31
	19-10	.059	- 56.00	- 56.00	- 3.38
	19-12	.057	41.04	104.96	3.43
	19-13	.056	31.30	84.31	3.33
	19-16	.054	24.47	- 14.41	- 3.30
13	13-10	.058	26.47	2 13.11	- 0.72
	13-11	.056	4.76	3.76	0.31
	13-12	.057	70.33	104.96	10.33
	13-13	.058	- 18.84	- 18.84	- 3.77
14	14-10	.058	8.58	11.58	1.01
	14-10	.059	19.54	26.54	0.78
	14-13	.055	27.54	14.03	- 0.69



Joint	Member	$\frac{P}{I}$	Case 11 1000 # at point 9		
			T	$2T_{TM} + T_{MM}$	f
1	1-2	.009	0.92	2.05	0.59
	1-3	.040	5.06		0.72
	1-4	.058	21.00	27.40	2.36
2	2-1	.058	-1.76	-11.84	-1.00
	2-3	.077	-8.47	-11.86	-1.48
	2-4	.052	-4.00	-70.15	-.60
3	3-5	.004	1.00	1.10	1.44
	3-6	.058	1.08	1.12	1.02
	3-7	.040	-5.75	-17.02	-1.54
	3-8	.077	58.84	-1.00	-14.00
	3-1	.000	-7.30	-1.00	-0.80
	3-4	.042	-7.03	-6.52	-0.49
4	4-2	.031	-1.70	-71.00	-2.12
	4-3	.032	-8.10	-11.53	-1.22
	4-5	.042	-17.10	-11.75	-30.11
5	5-6	.000	-0.00	-0.1	-.60
	5-7	.004	-1.10	55.10	-.48
	5-8	.000	-1.15	55.10	-1.72
	5-9	.000	-0.00	-0.00	-11.05
	5-1	.004	-1.00	-2.10	-1.70
	5-2	.004	1.02	27.11	-0.10
6	6-3	.032	1.00	27.12	-0.00
	6-4	.000	-0.00	-167.72	-1.00
	6-5	.035	-3.00	-27.58	-11.50
7	7-1	.000	1.00	1.00	10.00
	7-2	.000	0.00	0.00	0.00
	7-3	.000	0.00	0.00	0.00
	7-4	.000	0.00	0.00	0.00
	7-5	.000	0.00	0.00	0.00
	7-6	.000	0.00	0.00	0.00
8	8-1	.000	0.00	0.00	0.00
	8-2	.000	0.00	0.00	0.00
	8-3	.000	0.00	0.00	0.00
9	9-1	.000	0.00	0.00	0.00
	9-2	.000	0.00	0.00	0.00
	9-3	.000	0.00	0.00	0.00
	9-4	.000	0.00	0.00	0.00
	9-5	.000	0.00	0.00	0.00
	9-6	.000	0.00	0.00	0.00
10	10-1	.000	0.00	0.00	0.00
	10-2	.000	0.00	0.00	0.00
	10-3	.000	0.00	0.00	0.00
11	11-1	.000	0.00	0.00	0.00
	11-2	.000	0.00	0.00	0.00
	11-3	.000	0.00	0.00	0.00
	11-4	.000	0.00	0.00	0.00
	11-5	.000	0.00	0.00	0.00
	11-6	.000	0.00	0.00	0.00
12	12-1	.000	0.00	0.00	0.00
	12-2	.000	0.00	0.00	0.00
	12-3	.000	0.00	0.00	0.00
13	13-1	.000	0.00	0.00	0.00
	13-2	.000	0.00	0.00	0.00
	13-3	.000	0.00	0.00	0.00
	13-4	.000	0.00	0.00	0.00
	13-5	.000	0.00	0.00	0.00
	13-6	.000	0.00	0.00	0.00



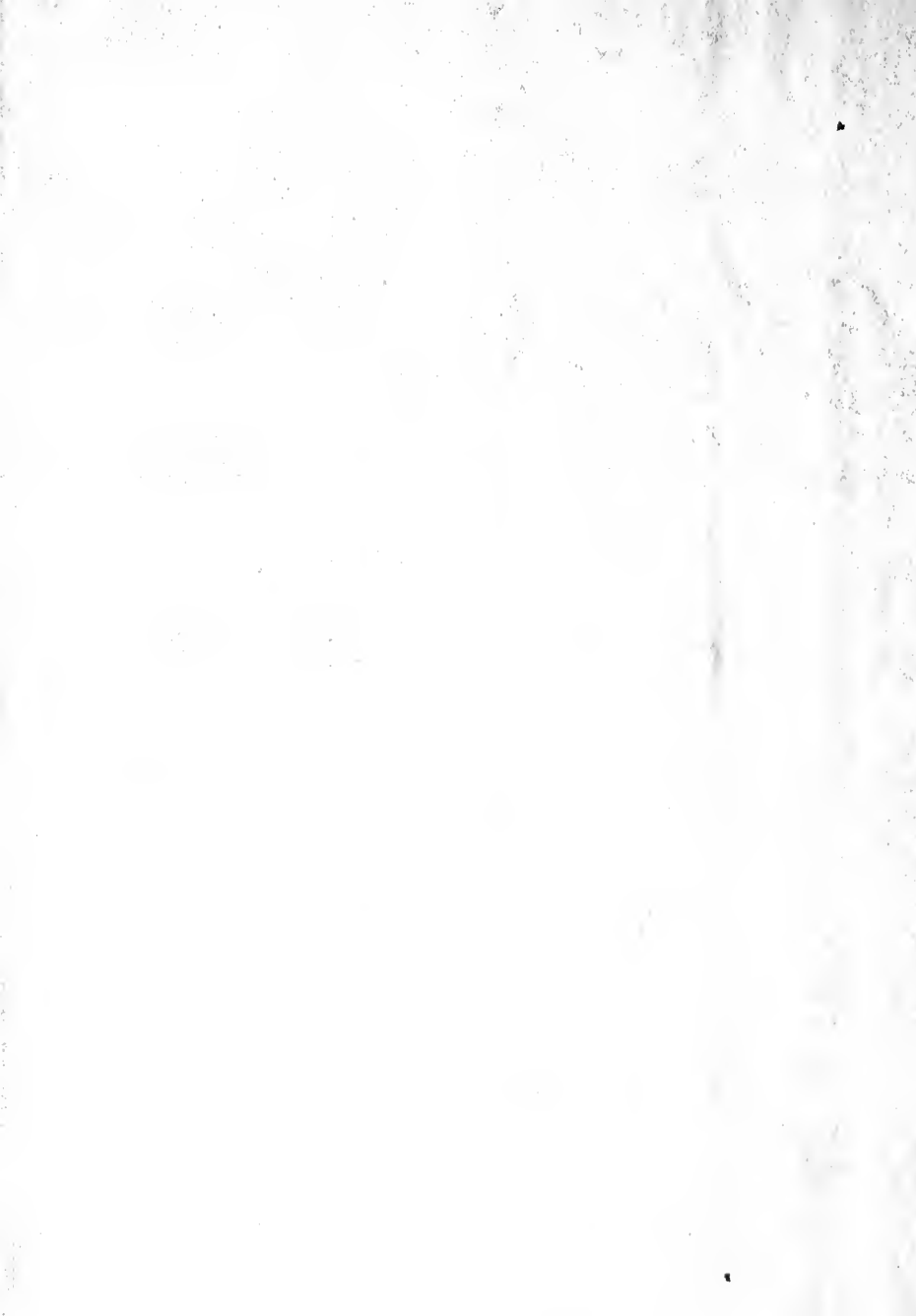
Joint	Member	$\frac{c}{I}$	Case 111 1000# at point 11			
			T	2T	T	f
1	1-2	.008	5.85	9.58		0.57
	1-3	.048	0.30	0.64	-	0.16
	1-2	.008	51.57	27.26		1.60
11	2-1	.050	- 12.07	- 6.53	-	5.13
	10-11	.016	50.20	96.40	-	1.91
	11-9	.008	534.97	364.15		13.89
	11-10	.048	58.76	29.38		1.15
	11-12	.008	- 148.14	- 269.65	-	6.79
12	13-13	.012	- 20.25	- 331.88	-	10.90
	13-13	.034	-	1.77		0.21
	13-14	.045	- 4.83	0.77	-	0.37
	13-15	.077	132.08	464.98		15.06
	13-16	.045	58.22	33.16		0.35
13	13-10	.002	29.44	- 48.27	-	0.09
	13-10	.033	17.43	- 68.11	-	2.41
	13-11	.048	7.50	- 36.08	-	2.10
14	13-12	.037	100.34	41.68		10.80
	13-14	.045	2.29	- 3.38	-	0.53
	14-15	.025	- 12.04	- 67.12	-	1.87
14	14-12	.039	17.61	20.27		1.28
	14-12	.045	17.61	59.87	-	1.34

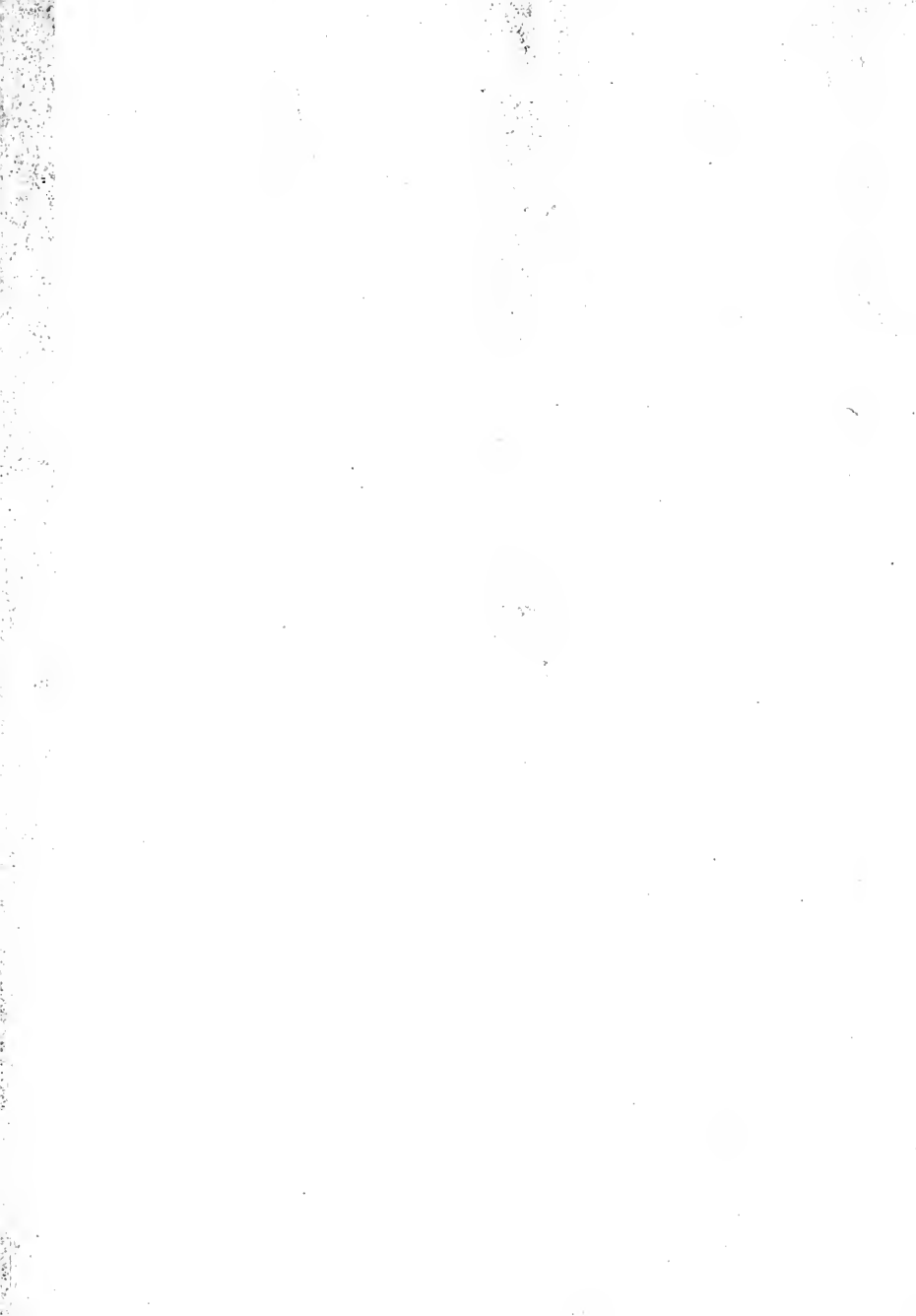


Date	Time	Lat	Long	Alt	Temp		Wind	Dir	Speed	Remarks
					Air	Surf				
1	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
2	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
3	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
4	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
5	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0
	14	14	14	14	14.0	14.0	14	14	14	14.0

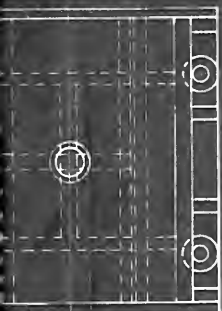
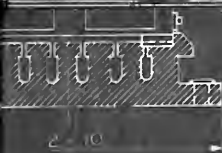
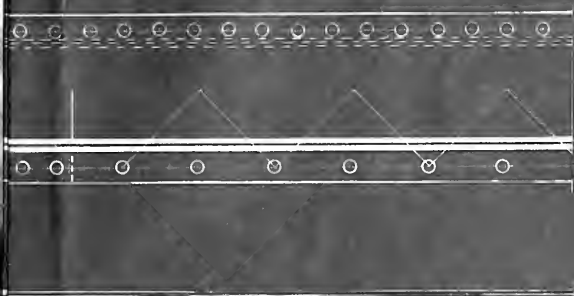


11	10-	.002	- 7.0	-00.02	-	.01
	10-0	.003	- 7.0	-00.01	-	0.06
	11-9	.001	- 7.7	- 1.7	-	0.4
	11-10	.001	- 17.00	- 0.01	-	1.00
	11-11	.001	- 1.0	- 17.0	-	0.0
12	11-10	.001	- 21.1	0.02	-	1.00
	11-11	.001	- 1.0	- 6.2	-	7.1
	11-12	.001	- 17.00	- 0.0	-	0.0
	12-10	.007	- 1.0	- 7.0	-	0.0
	12-11	.001	- 1.0	- 1.7	-	0.0
13	11-10	.001	1.0	0.00	-	1.00
	12-0	.001	7.0	70.0	-	0.0
	12-11	.001	- 1.0	- 0.0	-	1.0
	12-12	.001	- 1.0	- 1.1	-	0.0
	-	.001	- 1.0	- 1.7	-	0.0
14	12-10	.001	- 1.0	- 1.0	-	1.1
	12-11	.001	- 1.0	- 1.0	-	0.0
	12-12	.001	- 1.0	- 1.0	-	1.0

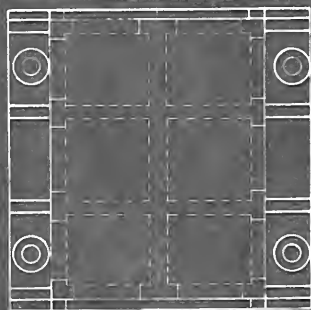








SHOE — FIXED END
 CASTING "D-CI" 1/2" METAL
 HOLES IN UPPER FACE FOR
 1/4" BOLTS
 HOLES IN LOWER FACE FOR
 1/2" ANCHOR BOLTS
 BEARING PL SAME AS FOR
 EXP END
 HOOKER SAME AS FOR
 EXP END EXCEPT 4 HOLES
 FOR 1/2" BOLTS IN
 CASTING "B"



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 HOLES 9/16" DIAM

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BRIDGE DESIGN

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Scale 1/2"

Nov '20

A. L. Stevens



